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ABSTRACT

An electrical power connector such as for coupling a plurality of electrical apparatus to a single source of mains electrical power. A single power inlet provides electricity to plural power outlets of which one is a master outlet and the others are slave outlets. First and second current senors and first and second switches are coupled between the power inlet and the power outlets for controlling the supply of electricity to the power outlets. The first current sensor senses current flow to only the master outlet, and the first switch controls electrical supply to the slave outlets so as to supply electricity only if the master outlet current exceeds a predetermined amount. The second current sensor senses unbalanced current flow in the reciprocal supply lines which provide electricity to the plural power outlets. If the current flow sensed is unbalanced then electrical supply to all of the master outlet and slave outlets is prevented. The unbalanced current flow is indicative of an earth leakage fault in the connector or one of the electrical apparatus coupled to the connector.

Regulation 3.2

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COMPLETE SPECIFICATION

FOR A STANDARD PATENT

(ORIGINAL)

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Invention Title: **"Electrical power connector"**

Details of Associated Provisional Application No: PN8584/96

The following statement is a full description of this invention, including the best method of performing it known to me/us:

ELECTRICAL POWER CONNECTOR

This invention relates to an electrical power connector, such as a single inlet multiple outlet power connector suitable for domestic or commercial use.

Frequency electrical apparatus for use in a domestic or commercial application can comprise a number of individual components, each of which operates from a separate power supply. For example, a computer for use in a home or office might comprise a central processing unit (CPU) which contains the processing circuitry, disc drives and the like. Attached to the CPU, and forming part of the computer system, may be a screen or visual display unit (VDU), a printer or plotter, a CD Rom and other peripherals which are operable by or with the CPU. The VDU, printer and other peripherals commonly have separate power supplies and thus require their own source of mains electricity, in addition to the mains electricity supplied to the CPU. In many applications, the screen, printer and other peripherals are only operable in conjunction with the CPU, yet their power supplies are separately controlled by individual on/off switches. The situation may be similar in many audio reproduction components systems, such as high fidelity stereo reproduction systems.

In some systems, especially computer and video games systems, when the main CPU is turned off the VDU goes blank. This often leaves the user in a false belief that the entire system is off when in fact the VDU, the printer and other peripherals are still in fact turned on. This can lead to expensive unwarranted power consumption but, more importantly, a genuine risk of fire especially when left unattended for long periods. In some instances, it may therefore be found desirable to control the supply of mains electricity to a plurality of components merely by switching a single component on or off. For example, it may be useful to switch off mains electrical power to a video monitor and printer of a computer system simply by switching off the CPU of that computer.

The multiple components of the types of electrical apparatus described above are

generally connected to the mains electricity via multiple mains electricity wall outlets, or alternatively, via a multiple power outlet board which is in turn connected to a single mains electricity wall outlet. In some instances, the location of the mains electricity wall outlets, or the multiple power outlet board, are inconveniently located and cannot be easily accessed without moving some of the surrounding components or furniture. Where multiple power outlet boards are located for accessibility there is usually the requirement for manual connection and disconnection of components, which can be dangerous to the consumer as the task is performed when the multiple outlet power board remains connected to a live mains electricity wall outlet. Also, when the multiple outlet power boards are positioned for accessibility there is sometimes the danger of the connecting leads being accidentally kicked and sometimes the possibility of the multiple power outlet board being subject to spillage of liquids which could lead to electrocution or fire. Furthermore, the multiple components of the types of electrical apparatus described above are generally interconnected for the passing of electrical signals therebetween, such as audio signals in the case of an audio system, or various digital and other control signals in the case of a computer system. If one of the components in the system were to develop an electrical fault, it is possible that undesirable electrical current could flow from one component to another. In that instance, it may be desirable to remove mains electrical power supply from all of the components of the system if a fault is detected in any one of the components.

The mains electricity wall outlets in some electrical distribution installations are controlled by a protection device designed to prevent consumer electrocution (Earth Leakage ELB, Residual Current Device TCD). Usually these devices are installed either at the mains electricity switchboard or alternatively at the first mains electricity wall outlet on a electrical supply circuit. Should an electrical fault be detected, this type of protection device will remove all mains electricity from all of the mains electricity wall outlets on the individually protected electrical circuit. This can cause many problems, especially in a commercial environment, when there are several computer systems connected to the mains electricity on the same electrical circuit.

Accordingly, there are applications in which it would be desirable to provide an electrical power connector which could be utilised to control the supply to power to certain components of a system and protect the system from electrical faults without unnecessarily affecting other systems.

In accordance with the present invention there is provided an electrical power connector comprising:

an electrical power inlet having a first and second reciprocal supply lines coupled to respective electrical inlet connections by way of a first switching means;

a first electrical power outlet coupled to the first and second supply lines through first and second current connections, respectively;

at least one second electrical power outlet coupled to the first and second supply lines by way of a second switching means;

a first current sensor for sensing unbalanced current through the first and second reciprocal supply lines;

a second current sensor for sensing current through one of the first and second current connections;

wherein the first switching means is operative to prevent supply of electrical current to the first and at least one second electrical power outlet if the net current sensed by the first current sensor exceeds a predetermined amount; and

wherein the second switching means is operative to connect the at least one second power outlet to the first and second supply lines if the current sensed by the second current sensor exceeds a predetermined amount.

Preferably the first switching means is bi-stable, wherein the first switching means connects the first and second supply lines to the respective electrical inlet connections in a first state, and disconnects the first and second supply lines from the respective electrical inlet connections in a second state, wherein the first switching means is operative to switch from the first state to the second state if the net current sensed by the first current sensor exceeds a predetermined amount. Preferably a reset switch is provided which is actuable to cause switching of the first switching means from the second state to the first state.

In accordance with the invention there is also provided an electrical power connector comprising:

a single electrical power inlet adapted to provide mains electricity to active and neutral supply lines by way of a first switching means;

a single master electrical power outlet for providing mains electricity to electrical apparatus in use connected thereto, the master electrical power outlet being coupled to the active and neutral supply lines through active and neutral current connections, respectively;

at least one slave electrical power outlet for providing mains electricity to respective electrical apparatus in use connected thereto, the at least one slave electrical power outlet being coupled to the active and neutral supply lines by way of a second switching means;

a first current sensor for sensing unbalanced current through the active and neutral supply lines;

a second current sensor for sensing current through one of the active and neutral current connections;

wherein the first switching means is operative to prevent supply of electrical current to the master and at least one slave electrical power outlet if the magnitude of the current imbalance sensed by the first current sensor exceeds a predetermined amount; and

wherein the second switching means is operative to connect the at least one slave power outlet to the first and second supply lines if the current sensed by the second current sensor exceeds a predetermined amount.

Preferably the first current sensor comprises a sensing coil through which both of the active and neutral reciprocal supply lines pass, such that when balanced reciprocal current flows in the active and neutral supply lines the voltage or current induced in the sensing coil is substantially zero.

In one form of the invention the electrical connector comprises a multiple power outlet adapter or power board, which includes a power source plug for coupling the electrical power inlet to a source of mains electricity and a plurality of power outlet

sockets for coupling the master electrical power outlet and the at least one slave electrical power outlet to supply mains electricity to respective electrical apparatus when plugged into the respective sockets.

The invention is described in greater detail hereinafter, by way of example only, with reference to the accompanying circuit diagram of an electrical power connector according to an embodiment of the invention.

The electrical power connector circuit 2 shown in the drawing is provided with active, neutral and earth electrical inlet connections 4,6,8, respectively, for connection, for example, to a mains electrical power source such as by way of a standard three-pin electrical plug. The active and neutral inlet connections are coupled to switching contacts of respective bi-stable relay switches 20 and 21 which are both operable by a relay coil 22. One switched terminal of each of the relay switches 20,21 are coupled to respective reciprocal supply lines 10,12. The supply line 12, in use, connects the neutral inlet connection to a master electrical outlet 16 and a plurality of slave outlets 18. A current connection 14 couples to the other supply line 10 to provide, in use, a connection between the master outlet 16 and active inlet connection 4. The slave outlets 18 are coupled to the supply line 10 by way of a relay switch 24 which is operable by a relay coil 25.

A second switched contact of the relay switch 21 to the neutral inlet connection 6 couples to a momentary action reset switch 50 in series with the relay coil 22 to the active inlet connection 4. A bridge rectifier 35 has AC connections coupled to the supply line 12 and between reset switch 50 and relay coil 22, and positive and negative DC connections coupled to respective positive and negative DC lines 36 and 37.

A first current sensor 30 comprises a first current sensing coil 31 which is arranged so that both the first and second supply lines 10,12 pass therethrough. The current sensing coil 31 is coupled to an operational amplifier 32 which provides an output to the control node of a transistor 33. The switching terminals (eg the collector/emitter

or source/drain) of the transistor 33 are coupled to the DC lines 36,37, and a capacitor 34 is coupled between the control node (eg base or gate) of transistor 33 and the negative DC line 37.

A second current sensor 40 comprises a second current sensing coil 41 which is arranged around current connection 14 which passes between the active supply line 10 and master outlet 16. The current sensing coil 41 is coupled to a second operational amplifier 42 having an output coupled to the control node of a transistor 43. The transistor 43 is connected in series with relay coil 25 between the positive and negative DC lines 36,37. A capacitor 44 connects between the control node of transistor 43 and the negative DC line 37.

The operation of the electrical power connector circuit 2 is as follows.

With power supplied to the electrical inlet connections 4,6,8, actuation of the reset switch 50 causes the relay coil 22 to be energised by connection between the active inlet connection 4 and neutral connection 6 through the normally closed switched contacts of relay switch 21. Energising the relay coil 21 causes the switching contacts of the relay switches 20 and 21 to switch, removing power from the reset switch 50 and switching both the active and neutral inlet connections 4,6 to connect to the supply lines 10,12 respectively.

Both the active and neutral supply lines 10,12 pass through the current sensing coil 31 of the first current sensor. When current flows equally through the reciprocal supply lines 10,12 the magnetic fields cancel each other out, and thus no EMF is induced in the current sensing coil 31. Accordingly, the amplifier 32 does not produce a significant output, and transistor Q1 remains switched off.

The master outlet and slave outlets conveniently comprise standard three-plug sockets for supplying mains electricity to electrical apparatus. If an electrical apparatus connected to any one of the master outlet 16 or slave outlets 18 develop an earth fault (eg

current flowing from active or neutral to earth within one of the electrical apparatus), a current imbalance will be induced in the supply lines 10,12. This causes current sensing coil 31 to present an induced voltage to the inputs of amplifier 32. The amplified output of amplifier 32 coupled to the control node of transistor 33 causes the transistor to switch on. Because the transistor 33 is coupled directly across the positive and negative DC lines 36,37 from the bridge rectifier 35, operation of transistor 33 causes a momentary short across the DC terminals of the bridge rectifier thereby drawing sufficient current therethrough to energise relay coil 22. As previously mentioned, the relay comprising relay coil 22 and relay switches 20,21 is a bi-stable relay, such that energising the relay coil 22 causes the connections between active and neutral electrical inlets 4,6 to the supply lines 10,12 to be broken. Actuating reset switch 50 resets the circuit as described hereinabove.

The current connection 14 which couples the active side of master outlet 16 to the supply line 10 passes through the current sensing coil 41 of the second current sensor 40. Thus, with no current flowing from the master outlet 16, due to no apparatus being connected thereto or the connected apparatus being switched off, no voltage is induced in the sensing coil 41. In this condition the output of amplifier 42 ensures that transistor Q2 is switched off, preventing electrical supply to the relay coil 25. Without electrical supply to the relay coil 25, relay switch 24, which connects supply line 10 to the active side of slave outlets 18 through normally open contacts, prevents electrical supply to the slave outlets. Conversely, when current flows from the master outlet 16, transistor 43 switches on, which also causes electricity to be supplied to the active side of slave outlets 18 through connection to the supply line 10 by way of relay switch 24 which is switched by energising of the relay coil 25. Accordingly, if electrical apparatus connected to the master outlet 16 is switched on, electricity is supplied also to the slave outlets 18, but if the electrical apparatus connected to the master outlet is switched off then electricity is prevented from being supplied to the slave outlets 18 through switching of the relay switch 24.

Preferably the bi-stable relay comprising relay switches 20,21 and relay coil 22

is a 100 milliamp device, whereas the relay comprising relay switch 24 and coil 25 is a 50 milliamp device. The particular components utilised to construct the electrical power connector circuit 2 will be apparent to an ordinarily skilled electrical engineer, circuits designer or the like.

Additional protection for the circuit and electrical apparatus connected to the master and slave outlets can be provided by an overload cut-out switch 52 which is coupled between the active inlet connection 4 and relay switch 20. Furthermore, lightening/surge arresting protection can be provided in a conventional manner, such as by way of gas discharge devices or the like coupled between the active and neutral inlet connections 4,6 and earth inlet connection 8.

It is also possible to provide for delayed switching of electrical supply to the slave outlets 18 following switching of the apparatus connected to the master outlet 16 by introducing a delay to the switching of transistor 43 of the current sensor 40. For example, the size of the capacitor 44 can be selected so as to introduce a charging delay at the control node of the transistor 43. A delay could similarly be provided in the current sensing circuit 30 by adjusting the value of capacitor 34 coupled to the control node of transistor 33.

Furthermore, the sensitivity of the current sensing circuits 30,40 can be provided with a degree of adjustability by arranging a suitable resistive feedback network between the output and input of amplifiers 32 and/or 42, as will be apparent to a person familiar with operational amplifiers.

The electrical power connector circuit 2 may conveniently be incorporated in an electrical connector such as power-board or double-adaptor for mains electricity. Alternatively, the circuit can be incorporated into, for example, a standard multiple power-point wall socket or the like.

Throughout this specification and the claims which follow, unless the context

requires otherwise, the word "comprise", or variations such as "comprises" or "comprising", will be understood to imply the inclusion of a stated integer or group of integers but not the exclusion of any other integer or group of integers.

The foregoing description of the invention has been put forward by way of example only, and modifications or variations thereto may be apparent to those skilled in the art without departing from the spirit and scope of the present invention which includes every novel feature and novel combination of features hereindisclosed.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. An electrical power connector comprising:

an electrical power inlet having a first and second reciprocal supply lines coupled to respective electrical inlet connections by way of a first switching means;

a first electrical power outlet coupled to the first and second supply lines through first and second current connections, respectively;

at least one second electrical power outlet coupled to the first and second supply lines by way of a second switching means;

a first current sensor for sensing unbalanced current through the first and second reciprocal supply lines;

a second current sensor for sensing current through one of the first and second current connections;

wherein the first switching means is operative to prevent supply of electrical current to the first and at least one second electrical power outlet if the net current sensed by the first current sensor exceeds a predetermined amount; and

wherein the second switching means is operative to connect the at least one second power outlet to the first and second supply lines if the current sensed by the second current sensor exceeds a predetermined amount.

2. An electrical power connector as claimed in claim 1, wherein the first switching means is bi-stable, such that the first switching means is adapted to connect the first and second supply lines to the respective electrical inlet connections in a first state and disconnect the first and second supply lines from the respective electrical inlet connections in a second state, wherein the first switching means is operative to switch from the first state to the second state if the net current sensed by the first current sensor exceeds a predetermined amount.

3. An electrical connector as claimed in claim 1 or 2, wherein a reset switch is provided which is actuable to cause switching of the first switching means from the second state to the first state.

4. An electrical power connector as claimed in claim 1 or 2, wherein the first current sensor comprises a sensing coil through which both of the first and second reciprocal supply lines pass, such that when balanced current flows in the first and second supply lines the voltage or current induced in the sensing coil is substantially zero.

5. An electrical power connector comprising:

a single electrical power inlet adapted to provide mains electricity to active and neutral supply lines by way of a first switching means;

a single master electrical power outlet for providing mains electricity to electrical apparatus in use connected thereto, the master electrical power outlet being coupled to the active and neutral supply lines through active and neutral current connections, respectively;

at least one slave electrical power outlet for providing mains electricity to respective electrical apparatus in use connected thereto, the at least one slave electrical power outlet being coupled to the active and neutral supply lines by way of a second switching means;

a first current sensor for sensing unbalanced current through the active and neutral supply lines;

a second current sensor for sensing current through one of the active and neutral current connections;

wherein the first switching means is operative to prevent supply of electrical current to the master and at least one slave electrical power outlet if the magnitude of the current imbalance sensed by the first current sensor exceeds a predetermined amount; and

wherein the second switching means is operative to connect the at least one slave power outlet to the first and second supply lines if the current sensed by the second current sensor exceeds a predetermined amount.

6. An electrical power connector as claimed in claim 5, wherein the first current sensor comprises a sensing coil through which both of the active and neutral reciprocal supply lines pass, such that when balanced reciprocal current flows in the active and neutral supply lines the voltage or current induced in the sensing coil is substantially

zero.

7. An electrical connector as claimed in claim 5 or 6, wherein the electrical connector comprises a multiple power outlet adapter or power board, which includes a power source plug for coupling the electrical power inlet to a source of mains electricity and a plurality of power outlet sockets for coupling the master electrical power outlet and the at least one slave electrical power outlet to supply mains electricity to respective electrical apparatus when plugged into the respective sockets.

8. An electrical connector substantially as hereinbefore described with reference to the accompanying drawings.

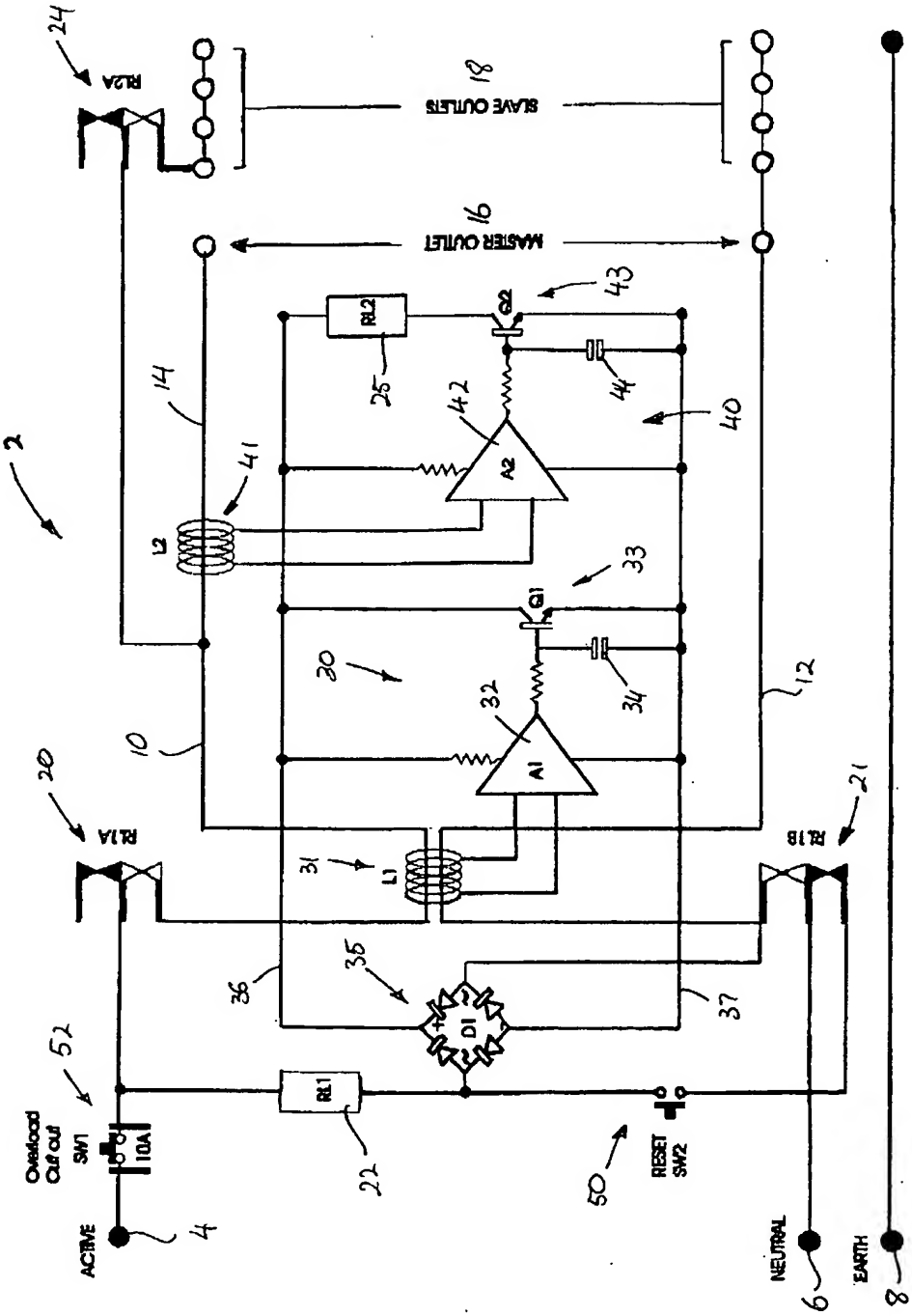
Dated this 11th day of March, 1997

ELECTRONIC SYSTEM INTEGRATORS PTY LTD

By its Patent Attorneys

Davies Collison Cave

16218/97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Electrical power conn ctor

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Abstract

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